Short and Easie

PROPOSITIONS,

Shewing the Method of taking

Heights & Distances;

ALSO

The WAY of MEASURING

LAND:

With other

Practical Observations

For the Use of such as are

Mathematically Inclin'd.

Collected out of the Best Authors; and Illustrated with 31 FIGURES Engraven in COPPER.

By *B. C.*

Printed for *Benj. Cole* near the *Theater* in *Oxford.* 1698.

To the Ingenious

Mr. JAMES CROSS,

Fellow of *New College* in *OXON.*

SIR,

I Was ſenſible with what Diſadvantage this ſmall Piece would Appear, without ſome Name (beſides my own) to Countenance it: Yours I have preſumed to make Choice of; well knowing that good Judges ever make the beſt Patrons: They Approve of Succeſsful, and Encourage even Weak Endeavours. You are Qualified for the Protection of a much greater Work; but to Encourage Science, tho' in its Infancy, is Meritorious. Your Speculations have carried you farther than Practice can poſſibly reach; yet, ſometimes to ſtoop from the

Height of Knowledge, to the Inferiour Parts of it, is not Inglorious: All Persons may not, perhaps, be acquainted with the Problems I propose, tho' Plain and Short, You undoubtedly are; for a Great Genius always takes the most Easie and Compendious Way to Knowledge: When you can spare Time from your deeper Speculations, be pleased to look favourably on the Endeavours of

SIR,

Your very humble Servant

Benj. Cole.

Short and Easie

PROPOSITIONS,

Shewing the Method of taking

Heights & Distances.

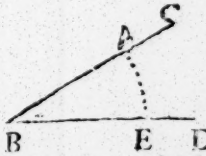
THE Instruments which are to solve the following Problems being to be bought very Cheap; I shall not trouble you with a Description of them: but shall lay down some necessary Rules for the better understanding of what shall be hereafter treated of.

I. *To shew what an Angle is.*

An Angle is the Space contained between Two Lines meeting in One Point; as the Space contained between the Lines BC and BD is an Angle.

II. *How to Write down an Angle.*

You must always place the Letter at the Point where the Two Lines meet; As in writing down the above-mentioned Angle, write it thus, CBD, or DBC; always placing B, (or that Letter which represents the Angle) in the midst.



III. *To lay down an Angle by the Line of Chords.*

Draw a ſtraight Line as BD (*ſee Fig. preced.*) and extend your Compaſſes to 60 Degrees upon the Line of Chords, then ſetting one Foot on B, with the other ſtrike an Arch as large as you think fit: then alſo from your Line of Chords take off as many Degrees as your Angle contains, and placing one Foot of your Compaſſes in the Bottom of the Arch, as at E, obſerve where the other cuts the Arch, ſuppoſe at A, draw the Line B C through the Point A; and this will be the other Line which forms the Angle CBD.

To lay down an Angle by the Protractor, ſhall be ſhewn when I ſhew you how to Protract an Obſervation taken in the Field by Surveying.

IV. *To Meaſure an Angle.*

Open your Compaſſes, and placing one Point in the firſt Degree of the Line of Chords, extend the other to 60. keeping them at this Diſtance, place one Foot in the Point B, (*ſee Fig. preced.*) and where the other falls, ſtrike an Arch, as the Arch A E; then with your Compaſſes meaſure the Length of the ſaid Arch, and ſee to what Degree from the beginning of the Line of Chords your Compaſſes will reach; ſo many Degrees as it reacheth, ſo many Degrees doth your Angle contain.

V. *To*

V. To lay down a Line of any aſſigned Length.

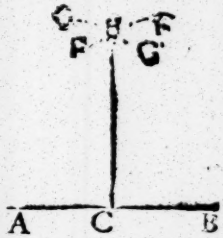
This is done only by taking off from your Scale of equal Parts, ſo many Parts as you deſign your Line to conſiſt of, and then draw the Line of that Length.

VI. *To Meaſure the Length of any Line by a Scale of Equal Parts.*

Extend your Compaſſes to the Length of the Line, and applying them at this Diſtance to the Line of Equal Parts upon your Ruler, as many Parts as are contained between the Points of your Compaſſes, ſo many Leagues, Miles, Chains, Feet, or any other Meaſure doth your Line contain.

VII. *To raiſe a Perpendicular from a Point in the Middle of a Line.*

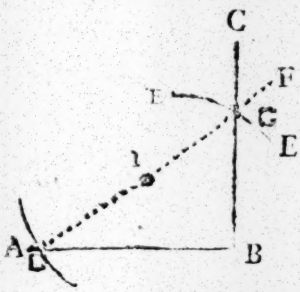
Suppoſe you would raiſe a Perpendicular from the Point C; Open your Compaſſes to any convenient Diſtance (exceeding half the Line,) and ſetting one Foot in the Point A, with the other deſcribe the Arch G G; then ſet your Compaſſes to B, ſtill keeping them at the ſame Diſtance, ſtrike the other Arch F F: laſtly, lay the Ruler from C to the Interſection of the



of the Two Arches F F and G G which is at H, draw the Line H C, which will be Perpendicular to the Line A B.

VIII. *To raiſe a Perpendicular at the extream End of a Line.*

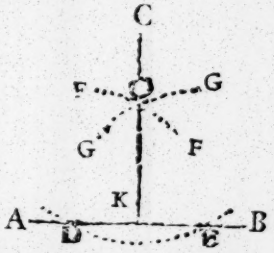
Suppoſe you would raiſe a Perpendicular at the End of the Line A B: Open your Compaſſes to any convenient Diſtance, and ſetting one Foot in B, let the other fall at random, ſuppoſe at the Point I, keep your Compaſſes at the ſame Diſtance, and from the Point I, deſcribe Part of a Circle which may croſs the Line A B in D; alſo on the other ſide deſcribe part of a Circle, as E E; then laying your Ruler from D to I, draw the prickt Line D I F: laſtly from the Point B, through the Interſection at G, draw the Line B G C, which is exactly perpendicular to the Line A B.



IX. *From a Point aſſigned, to let fall a Perpendicular upon a Line given.*

Let it be propoſed to let fall a Perpendicular from the Point C to the Line A B: Set one Foot of your Compaſſes at C, and with the other deſcribe part of a Circle, cutting the

the Line A B, in D and E; then open the Compaſſes to more than Half the Diameter of the Line A B, ſet one Foot in the Point of Interſection D, and deſcribe the Arch F F; do the like at E for the Arch G G: Laſtly, through the Point of Interſection O, draw the Line C K, which is a true Perpendicular. *Note*, This is only the Reverſe of the 7th Rule, the ſame you may do by the 8th Figure, *viz.* To let fall a Perpendicular to the end of a Line.



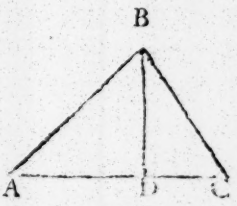
X. *To take the Angle of the Height of any Object.*

Hold up your Quadrant till through the Sights, you ſee the Top of that Object whoſe Height you would take; then lay your Left Thumb upon the Line that it may not ſtir, and obſerve on what Degree the String falls; thoſe Degrees reckon'd from the Beginning of the Quadrant, are the Degrees of the ſaid Angle.

To take an Angle of Diſtance will be ſhewn by the Tenth Problem.

XI. *To find the Superficial Content of a Triangle.*

Let fall a Perpendicular from the Angle oppoſite to the Baſe, as B D, then Multiply Half the Baſe by the Length of the Perpendicular, as Half the Baſe A C by the



Length

Length of the Perpendicular B D; or the Whole Baſe by Half the Perpendicular, and the Product is the Content: Or Multiply the Whole Baſe by the Whole Perpendicular, and Half the Product is the Content of the Triangle. *Note*, This Maxim holds good in all Triangles.

PROB. I. FIG. I.

To take an Acceſſible Height with a Quadrant at One Station.

LET the Diſtance B, repreſent your Station; from whence you would know the Height of the Tower C A: Take with your Quadrant, at B, the Angle of its Height (by Rule 10.) then meaſure the Diſtance between you and the Foot of the Tower; ſuppoſe 46 Feet, and (by Rule 3.) lay down the Angle of the Towers Height C B A, ſuppoſe 56 Degrees: Then at the end of your Line 46 Feet long, raiſe a Perpendicular; and where this Perpendicular meets with the other Line of your Angle, *viz.* B C, there is the Top of your Tower; which Perpendicular-Line meaſure on your Scale of Equal Parts, and you will find it to be 70 Feet, and ſo much is the Tower C A bove your Eye: to which, if the Ground be Level, you muſt add the Diſtance of your Eye from the Ground, which we ſuppoſe to be 5 Foot: ſo will you find the true

rue Height to be 75 Feet. *Note*, That the Quadrant gives you only the Height of the Object above the Level of your Eye, and not rom the Ground.

PROB. II. FIG. II.

To take an Acceſſible Height by the Shadow of the Object.

Let C A be a Tower, or any other Object whoſe Height you would know: The Sun caſting its Shadow on the Level Ground, ſuppoſe to B, there ſet up your Staff, and where that caſts its Shadow, ſuppoſe to E: Meaſure the Length of the Stick and its Shadow; and ſay by the Rule of Proportion, as the Shadow of the Staff, ſuppoſe 46 Inches, is to the Length of the Staff, ſuppoſe 38 Inches; ſo is the Length of the Towers Shadow, ſuppoſe 360 Inches, to the Towers Height 297 Inches.

PROB. III. FIG. III.

To take an Acceſſible Height by a Bowl of Water.

Let C A be a May-Pole whoſe Height you would know, having no Mathematical Inſtrument to take it with; Set a Bowl of Water on the Ground, ſuppoſe at B; when the Water is ſtill in the Bowl, go backwards in a right Line, from the May-Pole, till you ſee the Top of its Shadow in the middle of the Water, ſuppoſe at *a*, there make a Mark on the Ground, then meaſure the Diſtance from the Bottom of the May-pole A, to the Bowl of Water

Water B, which ſuppoſe 175 Inches, alſo meaſure the Diſtance from B, to your Standing *a*, ſuppoſe 72 Inches; then meaſure the Height of your Eye from the Ground, *viz.* *a c*, ſuppoſe 60 Inches: Then ſay, If the Diſtance B *a* 72 Inches, gives *a c* 60 Inches Height; what Height will the Diſtance A B 175 Inches give? which you will find to be $145\frac{5}{6}$ Inches: which is the Height of the May-pole.

PROB. IV. FIG. IV.

How to take an Acceſſible Height by the Help of Two Rulers joyned together Square-wiſe, or by a common Joyners-Square.

Let C A be the Tower whoſe Height you would know: Hold up your Square Perpendicular, which you may do by ſticking a Pin in the Top of the Square, and hanging a Thread and Plummet thereon; Keep it in this Poſture, and go backwards or forwards as Occaſion requires, till, your Eye lying at D, you can ſee the other End of the Square at the Top, and alſo the Top of the Tower at C all in a Right Line, which when you do, mark where you ſtand as at S, then meaſure the Height of your Eye from the Ground, ſuppoſe D S, and lay down the Length of it from your Station S to B, then meaſure the Diſtance from B to A, which will be the Height of the Tower C A.

PROB.

PROB. V. FIG. V.

To take an Inacceſſible Height at Two Stations.

If you would take the Height of the Tower C A, which you cannot do by reaſon of ſome River, Mote, or other Hindrance betwixt you and it; Chooſe your firſt Station, ſuppoſe at B, and there take the Angle of the Towers Height, which ſuppoſe to be 26 Degrees 30 Minutes; then go backwards, in a ſtraight Line, and chooſe your ſecond Station, ſuppoſe at b, and there take the Angle of the Towers Height, ſuppoſe, 39 Degr. 35 Min. Meaſure the Diſtance between your Two Stations B and b, ſuppoſe 64 Feet; Draw a Line on your Paper 64 Feet Long (by Rule 5.) and at the Beginning of it, make an Angle equal to the Angle taken at the Firſt Station, *viz.* 26 Degr. 30 Min. and draw the Line B C; then at the other End of the Line, make an Angle equal to the Angle of your Second Station, *viz.* 39 Degr. 35 Min. and draw the Line b C; where the Lines cut each other, there is the Top of the Tower: therefore from the Point C, let fall a Perpendicular (by Rule 9) and continue the Line b B till it meet with this Perpendicular, then meaſure the Length of the Perpendicular from A to C, the Points of Interſection, and that is the Towers Height above your Eye.

PROB.

PROB. VI. FIG. VI.

To take the Height of a Tower or any upright Object by the Shadow, when you cannot come to the Bottom of it, to measure the Length of the Shadow.

Suppose C A be a Tower whose Height you would know, but cannot by reason of some Moat or other Hindrance; Coming near the Moat-side, you find the Shadow of the Top of the Tower to be cast to the first B, I erect there a Stick of 4 Feet, or any other Length; the Length of the Shadow of this Stick, *viz.* B b, I find to be 32 Inches, which I note down, then sometime after, when the Sun is lower, I find the Shadow of the Top of the Tower to be cast to the second B, where I again erect the same Stick, and find its Shadow to reach to the furthermost b, and the Length of this Second Shadow to be 53 Inches, this I also set down, and measure the Distance between the Places where the Tower cast its First and Second Shadow, *viz.* the Distance B B, and find it to be 10 Feet or 120 Inches: Having these Numbers, you may find the Height of the Tower thus; As the Length of the Stick's Shadow, B c at the Second Observation 53 Inches, is to 48 the Length of the Staff; so is 120 Inches, the Length of the Shadow between the Two Places of Observation B and B, to 108 Inches, which 108 Inches I set down, and say, As 48 Inches, the Length of the Staff,

to 120 the Diſtance between the Two Sticks B B, ſo is 108, the Number laſt found, to the Towers Height, *viz.* 270 Inches, or 22 Feet and 6 Inches.

PROB. VII. FIG. VII.

To take the Height of a Cloud.

Let Two Perſons at two ſeveral Stations, as at b and B, in a ſtraight Line with the Cloud, obſerve exactly at the ſame Time, by ſome Sign, the ſame Part of the Cloud with Quadrants, and find the Angles A B C, ABC; then meaſure the Diſtance b B between the Stations, and proceed according to Prob. 5.

This may be done by One Perſon, if the Cloud be between him and the Sun, ſo that the Shadow of it fall behind him on a Place that he can exactly ſee: as ſuppoſe he ſtanding at B, takes with a Quadrant the Angle ABC, and obſerves the Shadow fall on B, then let him take, at the ſame Inſtant, the Suns Altitude, which will be always the ſame with the Angle A B C, then by meaſuring the Diſtance b B, and having the Angles AbC, ABC, find AC the Height by Prob. 5.

PROB. VIII. FIG. VIII.

How to take, at Two Stations, the Height of any Object that ſtands on the Top of any Hill, if you cannot come at the Foot either of the Hill, or the Object on the Top of it.

Suppoſe *Fig.* 8 to be a Beacon on the Top of Hill, whoſe Height you would know: Firſt (by

(by Prob. 5) take the Height of the Beacon and Hill together, then, by the ſam eRule take the Top of the Hill; Subſtract this laſt found Height from the firſt, and the Remainder is the Beacons Height.

PROB. IX. FIG. IX.

To find the Inequality of Places as to their Heights.

To find out the Difference of Heights of one Place from another in the Riſing and falling of Ground; Let your Inſtrument be made carefully, whether it be a Quadrant, Water-Level, or any other Inſtrument; a Braſs T is beſt; Let the Sights on the Top of it be Perſpective-Glaſſes, which muſt always ſtand one Way; there muſt be Two Mark-boards placed upon Quarter-Pikes, that Aſſiſtants may lift them Higher or Lower as they ſhall be directed: Set your Level, as near as you can, between the Two Marks your Aſſiſtants hold upright in their Hands with the Slipping-Marks; turning to one, cauſe him to hold the Slit and Black-ſtroak even with the Level-ſights, and ſo the other: the different Heights of theſe Sights in Inches, give the Aſcent or Deſcent; and this is for one ſimple Station: But if it require both Aſcents and Deſcents, then in a Note-Book ſet down your Back-ſtations in one Column, and your Fore-ſtations in another: Sum up both the Collumns, and take the Difference of them; if they be equal, the Two Places be Level; if your Fore-ſtations exceed the

the Difference is Lower; if otherwiſe, Higher. *See* Fig. 9.

PROB. X. FIG. X.

To take an Inacceſſible Diſtance at Two Stations by the Semicircle.

Suppoſe you were ſtanding at C or D, and would know the Diſtance from you to the Church B: Firſt, at one of your Stations, no matter which, ſuppoſe at C, place your Semicircle, laying the Index on the Diameter thereof, and turn the Semicircle about, till through the Sights you ſee the Church at B, and there ſcrewing faſt the Semicircle, turn the Index about, till you ſee, through the Sights, the Mark ſet up at the other Station D; and there note what Degrees the Index cuts, which we will ſuppoſe 110. Secondly, leaving a Mark at C, remove your Semicircle from thence to D your other Station; there fix your Semicircle as before, laying the Index on the Diameter, turn the Semicircle about till, through the Sights, you ſee the Mark at C, there ſcrewing it faſt, turn the Index about till, through the Sights, you ſee the Mark at B, and there alſo note what Degrees the Index cuts, ſuppoſe 40: Thirdly, meaſure the Diſtance between C and D, which ſuppoſe 120 Feet: by the help of theſe Three Things ſo found, you may have the Diſtance from C or D, to B, thus; Draw a Line on your Paper for CD, on which place 120 Feet;

then at C, lay down (by Rule 3) an Angle of 110 Degrees, and at D, an Angle of 40; then measure the Line C B, which is the Distance of the Church B from C; likewise the Line D B is the Distance of the Church B, from D.

PROB. XI. FIG. XI.

How to take the Breadth of a River by a Square.

Let A represent one Side, and B the other Side of the River, whose Breadth you would know by the Help of the Square only: On the Bank of the River at A, set up a Staff, which suppose to be 60 Inches Long; hanging your Square on the Top thereof at C, look by the Side of it, till you see the Bank of the River on the other Side, *viz.* at B; and there extending a Thread by the Side thereof, from C to b; then measure the Distance of A b, which suppose 15 Inches: Then by the Rule of Proportion say, As the Distance A b 15, is to C A the Staff's Length 60 Inches; so is the said C A 60, to the River's Breadth A B 240 Inches.

PROB. XII. FIG. XII.

How to find the Distance between Two Places, both of which are removed from the Observer.

Suppose B and D to be the Two Places: Choose Two Stations C and G: at C, your first Station, take (by Rule 10) the Angle B C G; and at your Second Station G, the Angle

Angle B G C. First (by Rule 3) lay down the Angle B C G, and having drawn the Lines B C and C G, measure the Distance between the Two Stations C and G; and at G, draw the Line B G, and where this Line cuts the Line B C, there is one of the Places, *viz.* B: then at G, take the Angle D G C, and at C, the Angle D C G: lay down these Two Angles as before, and draw the Lines D C and D G; and where those Two Lines cut each other, as in D, there is the other Place, *viz.* D: Draw a Line from D to B, and measure it on the same Scale of Equal Parts on which you measured C G, and that is the Distance between the Two Places B and D. *Note*, This will be better demonstrated in the next Problem.

PROB. XIII. FIG. XIII.

To take the Distance between Two or more Places, without coming near any of them by a Two feet Joynt-rule.

Suppose the Two remote Places were A and B, whose Distance I would know: I make Choice of a Place at C, from whence I can see both the Places A and B; there I set up a Staff whereon to rest my Rule horizontally; and opening it to a Square Angle, I look by one Side of it, till I see my first Place at A; and there keeping it Fast, and Level, I look by the other Side of it, and cause a Mark to be set up in a Right-Line from C, at a competent Distance, as at D, suppose 150 Feet; then close in your

Rule, till, by the Side thereof, you ſee the Second Place at B; keep your Rule at that Angle: then upon a Paper, Board, or Slate, draw Two Right Lines as A C and D C, making a Right Angle at C: then bring your Rule at the ſame Angle it was when you lookt to B, and lay the Center of the Rule upon C, and by the Side thereof draw the Line C B: and becauſe your meaſured Diſtance between C and D was 150 Feet; take from your Scale of Equal Parts 150, and ſet them down from C to D: then take your Rule and go to D, and ſet the Center of it upon the Staff, look by one Side of it to C, and by the other to A; then bring your Rule to the Board on which you draw, and lay the Center of it on D, and one Side on the Line D C, and by the other Side draw a Line at Length, as the Line D A, croſſing the Line A C in A; ſo ſhall A on your Board repreſent the Place A in the Field. Again take your Rule and go to D, and there reſting it on the Staff, look by one Edge to A, and by the other to B, and keeping it at that Angle bring it to the Board, and lay one Side upon the Line D A, and by the other draw the the Line D B, which will croſs the Line C B in B; ſo ſhall B on the Board or Paper repreſent B in the Field: the Line B A on your Paper is the Diſtance ſought, which if you meaſure by the ſame Scale you meaſured D C by, you will find it to be 255 Feet: and by this Means you may find the Diſtance of all the Places in the Figure, as C A, D A, or C B.

PROB

PROB. XIV. FIG. XIV.

How, by a Semicircle, to take the Plot of a Country, City, Bay, or Harbour, or ſuch like Place, at Two, or more Stations.

Suppoſe C D I F K L to be ſeveral remarkable Places in a City, whoſe Plot you are minded to take: Make Choice of Two Places for your Stations, at A and B, let them be (if conveniently you can) near the Breadth of the City; then ſetting up your Semicircle at A the firſt Station, turn it about (keeping the North-point from you) till through the fixed Sights you ſee the Mark at the ſecond Station B, there Screw faſt the Inſtrument; then turn the movable Index to every ſeveral Mark, *viz.* C D I F K L, and ſee what Degrees are cut thereby at every Mark, which note down in a Book, ſuppoſe C 25, D 92, I 139, F 244, K 288, L 330, theſe for your firſt Station; then meaſure the Diſtance between your Two Stations, which ſuppoſe to be 38 Chains, and ſet this down in your Book; Next, placing your Inſtrument at B, your ſecond Station, look through the Sights till you ſee your firſt Station, there ſcrewing your Inſtrument faſt, take the Angles as at your firſt Station, ſuppoſe C 30, D 139, I 146, F 249, K 342, L 350, theſe for your ſecond Station.

PROB.

PROB. XV. FIG. XIV.

How, by the Protractor, to Plot or lay down on Paper the foregoing Obſervations.

Firſt draw a Line on your Paper at pleaſure as the Line *a b*, then take from off your Line of Equal Parts the Stationary Diſtance, 3 Chains, and ſet it on the Line from *a* to *b*, ſo will *a* repreſent the firſt Station, and *b* the ſecond.

Secondly, Apply the Center of your Protractor to the Point *a*, and the Diameter thereof lying ſtraight on the Line *a b*; Count on the Edge of it 25, and there make a Mark for the Angle C; 92 for the Angle D, and ſo for all the reſt. Then place your Protractor at *b* the ſecond Station, and there mark out your Angles as before at the firſt Station: obſerve that for thoſe Degrees which exceed 180, you muſt turn the Protractor downwards, keeping ſtill the Center as before, and the Diameter on the Line *a b*, and mark out by the innermoſt Circle of Diviſions the reſt of your Obſervations, as 244, 288, *&c.*

Having thus made Marks on your Paper for every Angle at both Stations, draw Lines from each Station to its reſpective Marks; as the Lines *a l*, *a k*, *b c*, *b d*, &c. and where theſe Lines cut each other, you muſt ſet down the remarkable Places.

PROB

PROB. XVI. FIG. XV.

How to take the Horizontal Line of a Hill.

Suppoſe *Fig.* 15, to be a Hill whoſe Horizontal Line you would know: At the Top of the Hill, *viz.* C, ſet up a Mark of the ſame Height with your Eye at B, then (by Rule 10) take the Angle C B A, ſuppoſe 40 Degrees; meaſure the Diſtance C B ſuppoſe 30 Chains, draw a ſtraight Line to repreſent b *a* A B, and (by Rule 3) lay down the Angle C B A 40 Degrees; continue the Line C B 30 Chains Long, and from C let fall the Perpendicular C A; then meaſure the Breadth of the Top of the Hill, *viz.* *C* C Suppoſe 34 Chains; then ſtanding at *C*, take (by Rule 10) the Angle *C* b, and having from C drawn the Line *C* C 4 Chains Long, let fall the Perpendicular *a*, cutting the Line b *a* A B in *a*, then alſo (by Rule 3) lay down the Angle b *C a*, ſuppoſe 8 Degrees; and where the Line *C* b cuts the Baſe Line b *a* A B, from the Point, *viz.* from to B is the Length of the Horizontal Line, which meaſured on the Scale of Equal Parts, will give you the Number of Chains the Length of it contains.

THE Figures from the Sixteenth to the Twenty-third belong to Surveying, which I ſhall ſhew how it may be done, only by the Semicircle and Chain.

How

PROB. XVII. FIG. XVI.

How to take the Plot of a Field at One Station.

Having placed your Semicircle at T, take all the Angles, *viz*, A B C D E F, (as in Prob. 14) and note them down; then with your Chain measure in a ſtraight Line from your Station T, to all the Angles, and ſet down the ſeveral Diſtances; having done this, draw the Line N S on a Piece of Paper, and Protract your Angles (as in Prob. 15) then from the Point T to each of the Marks for the Angles, draw the Prickt Lines A T, B T, C T, *&c.* and ſet their particular Diſtances on them; and at the End of each Diſtance, draw the Lines A B, B C, C D, D E, *&c.* Thus have you the Plot of the Field; then to find the Superficial Content of it; divide it into Triangles, by drawing a Line from A to C, from A to D, from A to E, and (by Rule 11) find the Superficial Content of each Triangle; then by adding all the Contents together, you will have the Superficial Content of the whole Field.

PROB. XVIII. FIG. XVII.

How to take the Plot of a Field at Two Stations, when you cannot ſee all the Angles at either of them.

At your firſt Station, take all the Angles at one End, and their reſpective Diſtances from your Standing, as before; then meaſure

he Diſtance between the Two Stations, and ake all the Angles at the other End, and their particular Diſtance from your ſecond Station: Having done this, lay down all your Angles nd their Diſtances belonging to the firſt Staion, and likewiſe all thoſe which belong to he ſecond Station (according to the foregong Directions) and then draw the Lines AB, BC, CD, DE, EF, *&c.* and thus have ou the Plot of the Field, whoſe Content find s before.

PROB. XIX. FIG. XVIII.

How to take the Plot of a Field at Two Stations when you can ſee all the Angles from both.

Place your Semicircle at your firſt Station, nd take there all the Angles, ſetting them down in your Field-Book; do the ſame at your ſecond Station, and protract all the Angles, (as in Prob. 15) and where thoſe Lines interſect each other, as in A, B, C, *&c.* there are he Angles: from theſe Points draw the Lines AB, BC, CD, *&c.* ſo have you the Figure of the Field, whoſe Content is found as before. This is the ſame with *Prob.* 15. and by one or the other of theſe Ways, may be found out the Content of any Field by the Semicircle.

Note, That when the Hedges are not Straight Lines, but are more or leſs Crooked either Inward or Outward; in ſuch Caſes, the Content will be more exactly found, if in the

the midſt of this Bending you ſet up a Mar and reckon it for an Angle.

PROB. XX.

How to turn any Number of Chains and Link into Acres, Roods, and Perches.

You are to obſerve that the Chain I men tion, is the ſame which Mr. *Gunter* adviſes all Perſons to make uſe of, being Four Pearches in Length, each Pearch containing Sixteen Feet and an Half; ſo that the whole Chain is 66 Feet Long, and conſiſts of 100 Links, every Link being 7 Inches and $\frac{92}{100}$. Note alſo that 160 Square Perches make an Acre, and that 40 Square Perches make 1 Rood or the 4th Part of an Acre: So that 10 Square Chains (1 in Breadth and 10 in Length, or 2 in Breadth, and 5 in Length) make an Acre. Now to turn any Number of Chains into Acres, you muſt divide them by 10, and the Quotient will be the Number of Acres contained in ſo many Chains. But this Diviſion is Abreviated by cutting off the laſt Figure; as if 1590 Chains were given you to turn into Acres; cut off the Cipher 0, and there will be left 159 Acres. But if Chains and Links be given you together to turn into Acres, Roods, and Pearches; firſt from the given Sum cut off Three Figures, which is Two for the Links, and One for the Chains, what's left ſhall be Acres. To know how many Roods and Pearches are contained in

the Figures cut off, Multiply them by 4, nd cut off from the Product the Three laſt Fi-ures, the reſt ſhall be Roods: then to know he Pearches, Multiply the Figures cut off om the Roods by 40, and again cut off hree Figures, the reſt are Pearches; and the hree Figures cut off, are Thouſandth Parts f a Pearch.

PROB. XXI. FIG. XXIV.

How to take the Height of an Object with more Certainty than is before mentioned.

Let B and b repreſent Two Stations, not in Right-Line, but as equally Diſtant from the bject C A as you can, and obſerve the An-les B and b, and at each Station the Angle f Altitude; having meaſured the Diſtance etween the Two Stations, draw on a Piece f Paper (by Rule 5) a Line of that Length s the Line B b, and at B and b, lay down he Angles C B b, C b B equal to thoſe you ave obſerved; and let the Lines C b and B cut each other in C; draw alſo the Line A, making the Angle C B A equal to the ngle of Altitude; then from the Point of nterſection C, let fall the Perpendicular C A, utting the Line B A in A, ſo is the Line C A he true Height ſought.

PROB.

PROB. XXII. FIG. XXV.

To take the Height of an Object only by a Stick.

Suppoſe *c a* to be a Stick, (or a Wall, or another Object) of a given Height perpendicularly erected; then draw back from the Stick till aiming by the Extremity *c*, you can diſcern the Top of the Tower C: then meaſuring the Diſtance between B *a* and *a* A, ſay, As B (the Diſtance between your Station and the Bottom of the Stick) is to *c a* the Height thereof; ſo is B A (the Diſtance between your Station and the Foot of the Object) to C A the Height of it.

PROB. XXIII. FIG. XXVI.

To meaſure an Inacceſſible Height when you cannot ſtand in a Plain.

From the Foot B and the Top D of a High Place whoſe Height is known, take the Angles of the Height of the Object; then on Paper draw an infinite Right-Line, as B A on this raiſe a Perpendicular (by Rule VIII) as B E, on which place B D the given Height of the Tower or Place you ſtand on; then let the Angle E D C be equal to the Complement of the Angle obſerv'd at the Top and the Angle E B C equal to the Complement of the Angle obſerved at the Foot: the fro

om C, the common Section of the Right ines D C and B C, let fall the Perpendi- lar C A to B A; ſo ſhall C A be the Height, d B A the Diſtance.

PROB. XXIV. FIG. XXVII.

ow to meaſure the Diſtance C B *which has but One Extremity Acceſſible, only by the Chain.*

From C, draw the Right Line C D, ſo that s Extremities C and D, may be, as near as oſſible, equidiſtant from the Point B; then the Lines of Sight, C B, D B, take any two oints, as E, F, and meaſure with a Chain e Right Lines F C, D C, C E, F E, E C; from hich, deſcribe the Trapezium C D E F; then roduce the Lines D F and C E till they meet B: ſo is C B the Diſtance ſought.

Note, That if the Points E F cannot be ta- en between C B and D B, take the Points F in the Lines C B, D B produc'd on the her ſide: for the Longer the Sides of the rapezium are, the more exact will the Mea- re be. By this Method, the Breadth of a iver may be Diſcovered.

PROB. XXV. FIG. XXVIII.

To meaſure the Height of a Hill from its Top.

Let P B be the Height of a Hill; from the op thereof, view the Surface of the Sea, and ſerve the Angle A B C: therefore in the Tri- angle

angle BAC, the Angles and the Side CA a
given; therefore, BC will be known; an
conſequently, PB will be equal to BC--PC.

The Eaſineſs of this Method is evident fro
hence, becauſe it requires no Baſe: but it h
this Inconvenience, that on the Top of Hig
Hills the Surface of the Sea can hardly b
diſtinguiſhed from the Air, unleſs you ob
ſerve the Angle B, by viewing the Horizon
while the Center of the Sun or Moon riſe
thence.

PROB. XXVI. FIG. *Preced.*

The Diſtance AP *being given, from whence t
Top of the Hill begins to be Viſible; how t
find its Height* PB.

The Arch AP is equal to the Angle C
therefore in the Triangle BAC, the Angle
and the Side CA being given, CB will be alſ
given; and PB will be CB--CA.

*How much Refraction hinders the Practice
taking the Heights of Hills.*

Refraction makes the Hills appear High
than in reality they are; and if there is varie
of Refractions, or a continued Refracti on
reaſon of the different Denſity of the Air, th
Objects will appear ſo much Higher than i
there was but one Refraction.

PROB

PROB. XXVI. FIG. XXIX.

he Diſtance of a Hill being given, and the Semidiameter of the Earth (21039008 Engliſh-Feet) *to find its Height.*

Suppoſe C to be the Center of the Earth, the Obſerver, BA the Horizon of the Obrver touching the Surface of the Earth in A, d PM the Height of the Hill: in the Trigle ACM, the Angles A, C, and the Side A are given; therefore CM will be given, d CM--CA is equal to PM the Height ught.

PROB. XXVII. FIG. XXX.

find the Diſtance of the Sun, Moon, or Stars.

Let C be the Center of the Earth, and A e Superficies, where you obſerve the Star B its Horizon; the Angle at B, which is call- the Horizontal Parallax, may be found by tronomy. Therefore in the Triangle CAB, e Three Angles, and the Semidiameter of e Earth being given, by Trigonometry, e Sides AB and CB are known.

PROB.

PROB. XXVIII. FIG. XXXI.

To take the Height of the Sun by a Quadrant

Hold up the Quadrant, ſo that the Strin may move eaſily by the Side thereof; th turning your ſelf to the Sun, raiſe or depre the Quadrant, till you perceive it to ſhi directly through both the Sights; then o ſerve on the Limb what Degrees the Strin cuts, and thoſe counted from the contra Side to the Sights, will give you the Heig of the Sun at that Time.

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PROB. XXVIII. FIG. XXXI.

To take the Height of the Sun by a Quadrant.

Hold up the Quadrant, ſo that the Strin may move eaſily by the Side thereof; the turning your ſelf to the Sun, raiſe or depre the Quadrant, till you perceive it to ſhin directly through both the Sights; then ob ſerve on the Limb what Degrees the Strin cuts, and thoſe counted from the contrar Side to the Sights, will give you the Height of the Sun at that Time.

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Fig 8

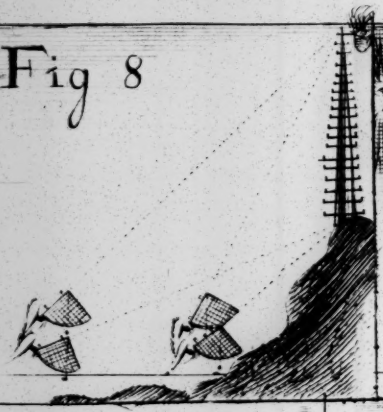


Fig 7

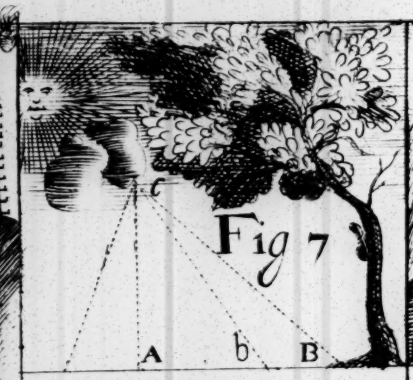


Fig 6

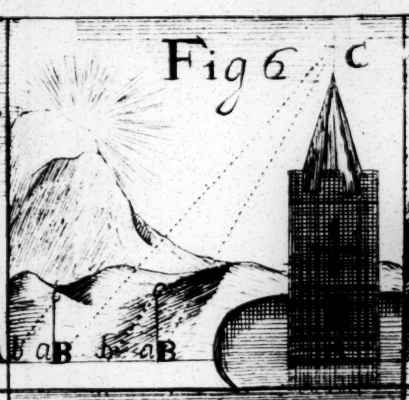


Fig 5

Fig 15

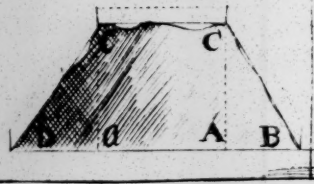


Fig 14

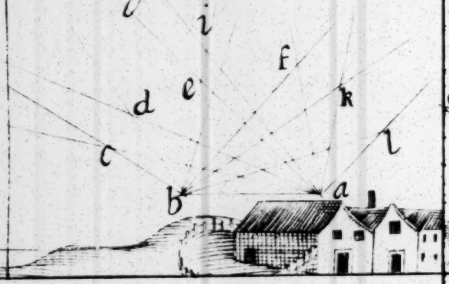


Fig 14

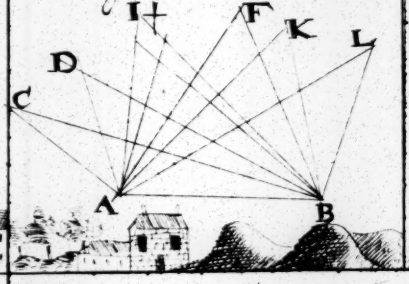


Fig 13

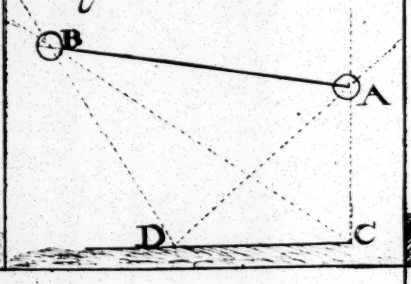


Fig 19

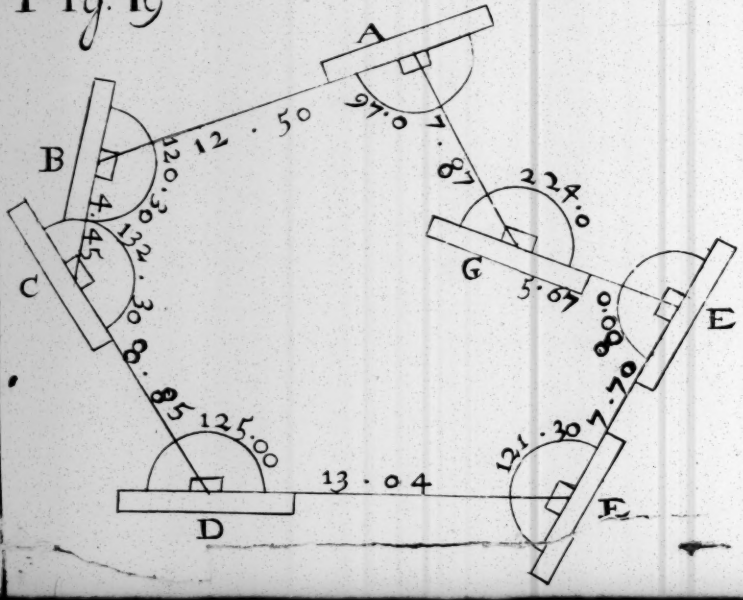
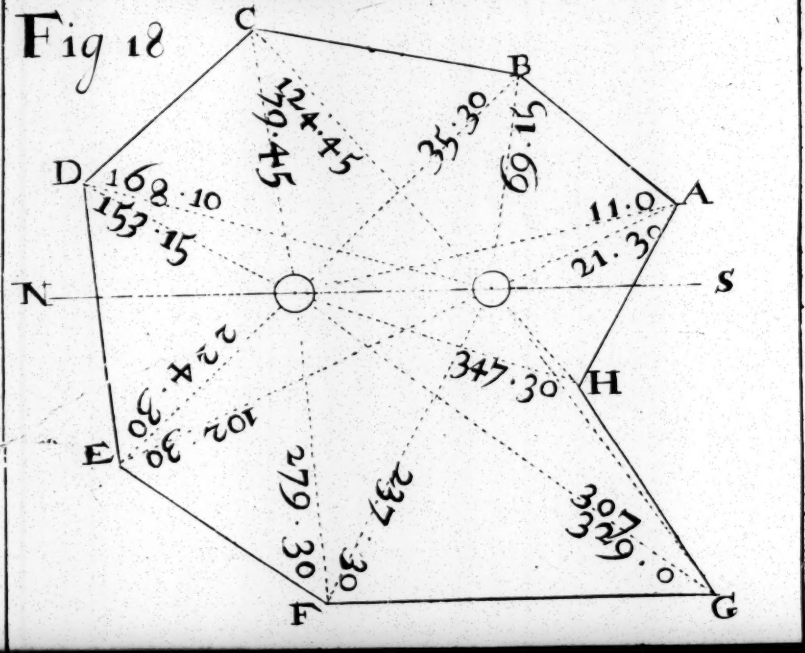


Fig 18



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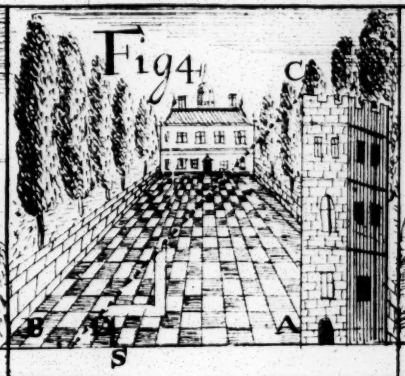


Fig 3

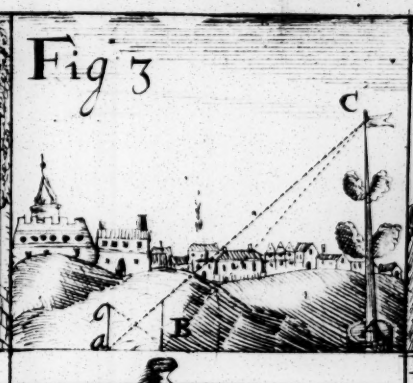


Fig 2

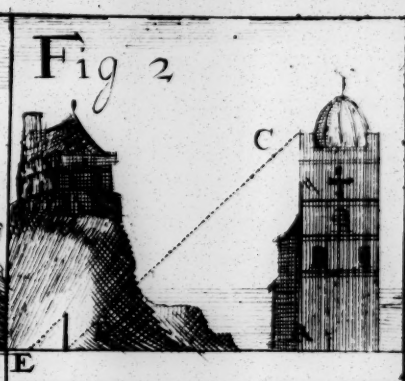


Fig 1

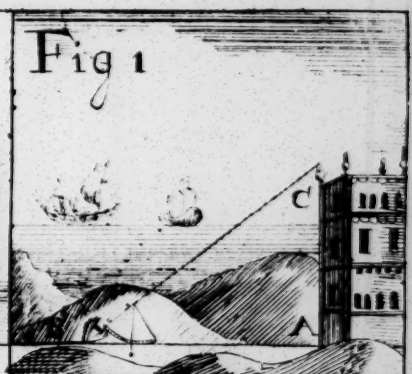


Fig 12

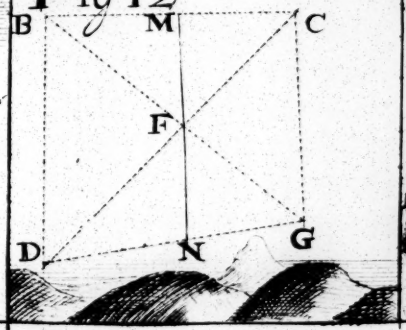


Fig 11

Fig 10

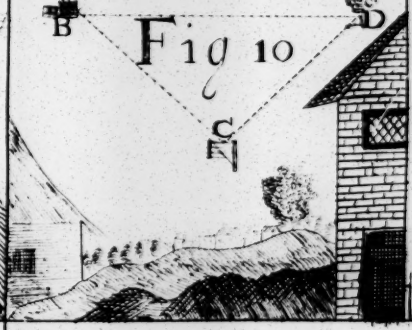


Fig 9

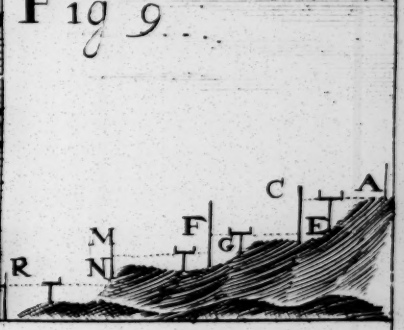


Fig 17

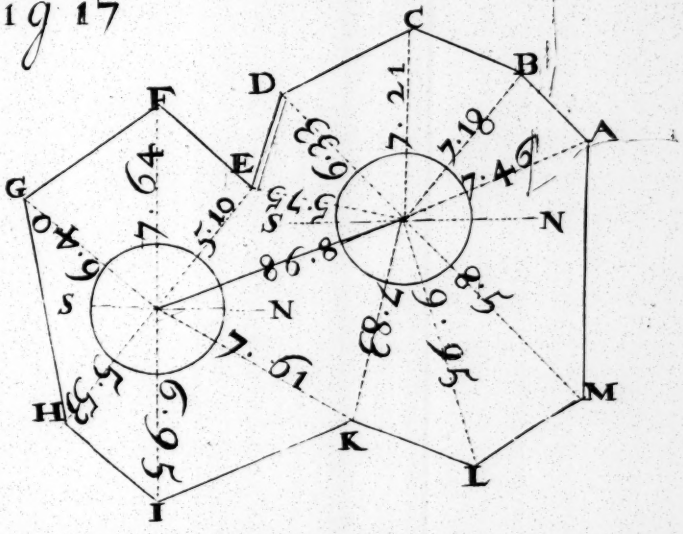
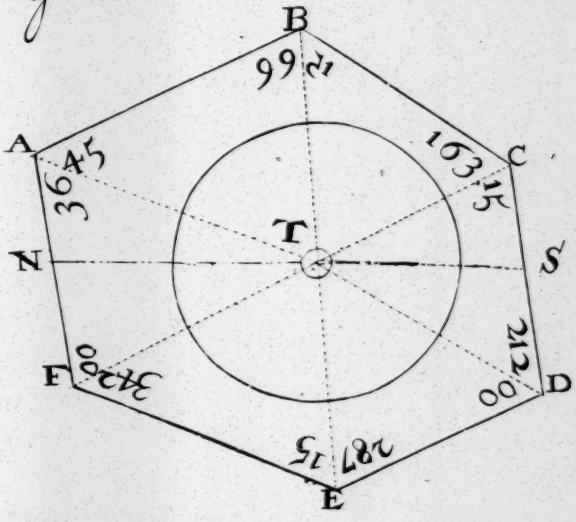
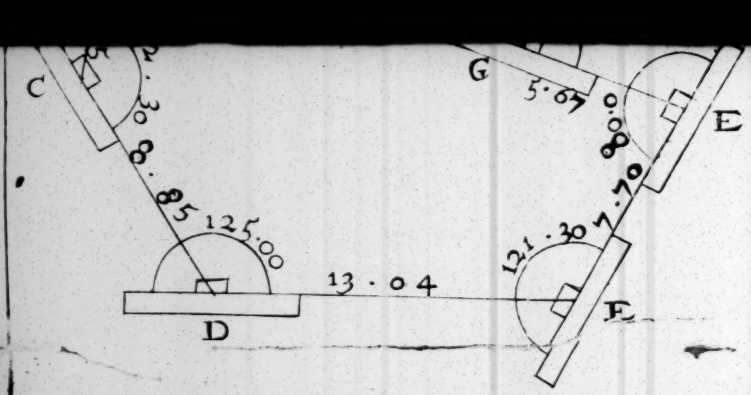


Fig 16





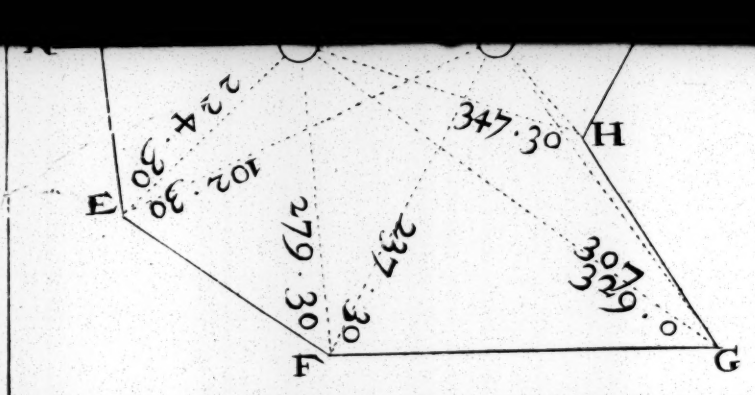
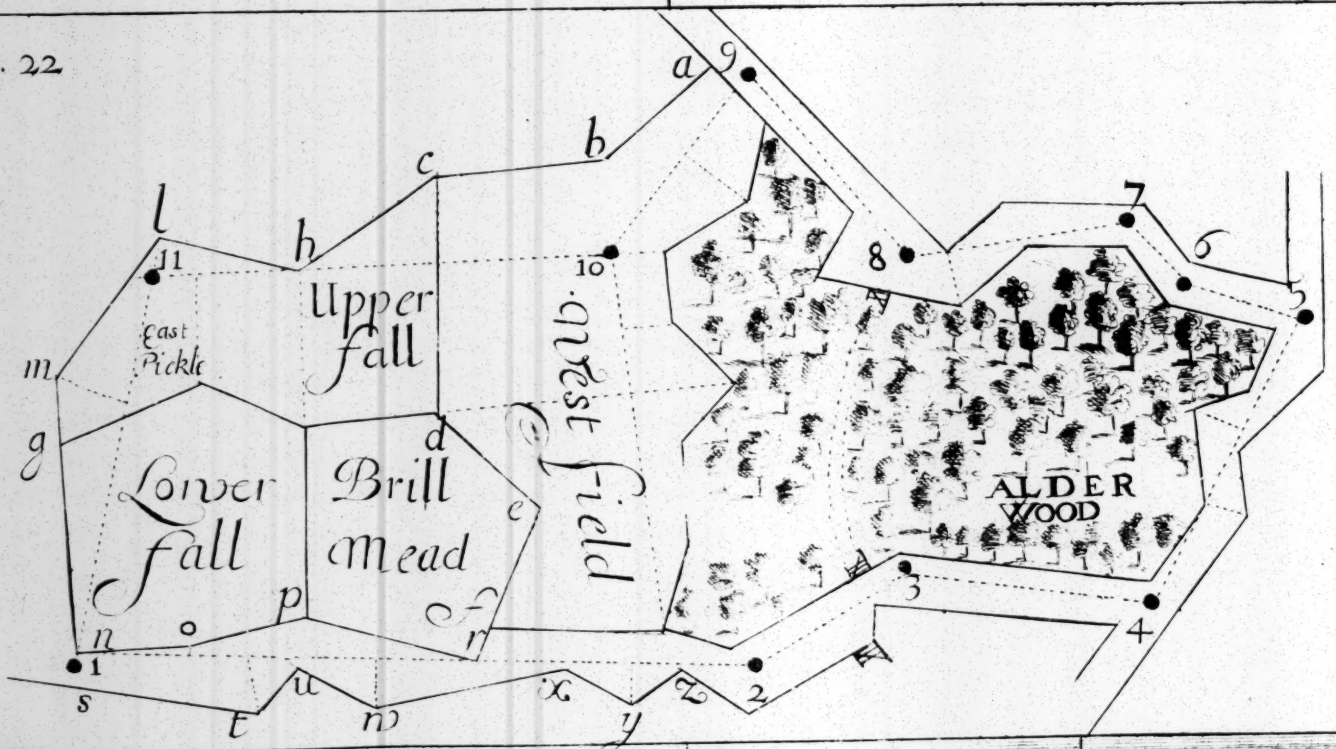
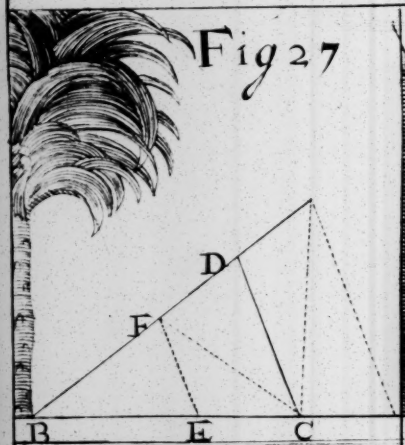
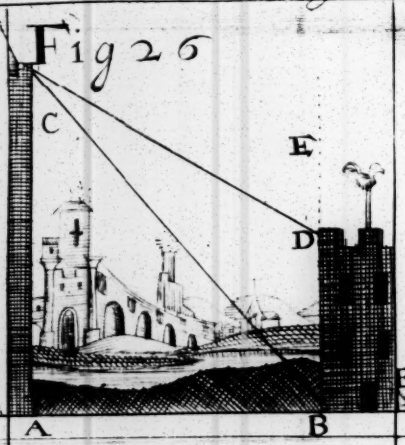
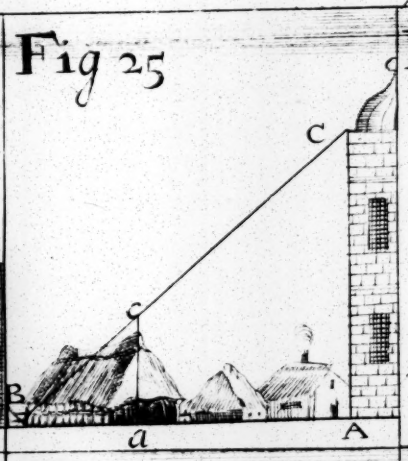


Fig. 22









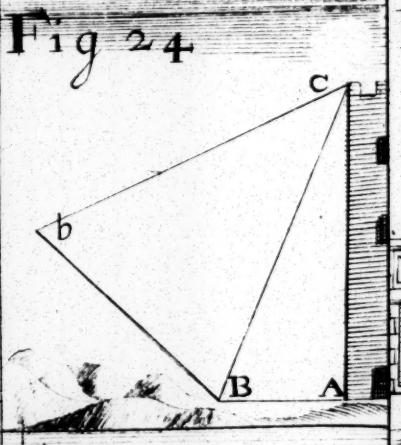
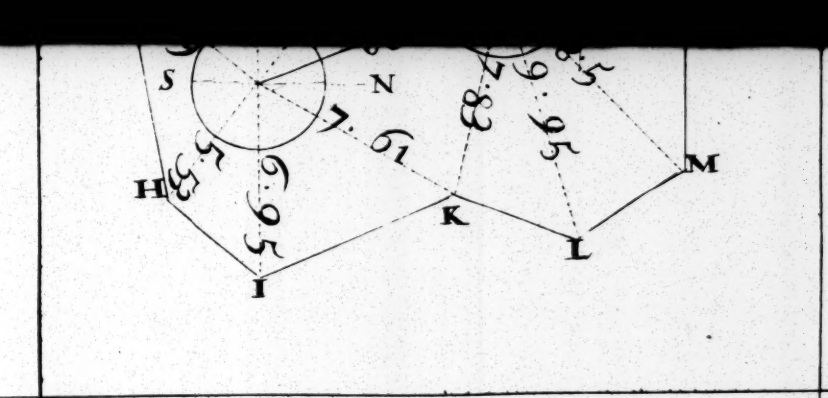


Fig 31

Fig 29

Fig 28



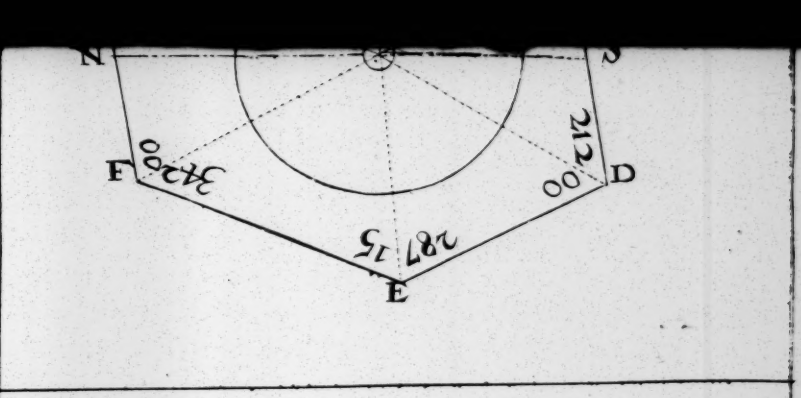


Fig 21

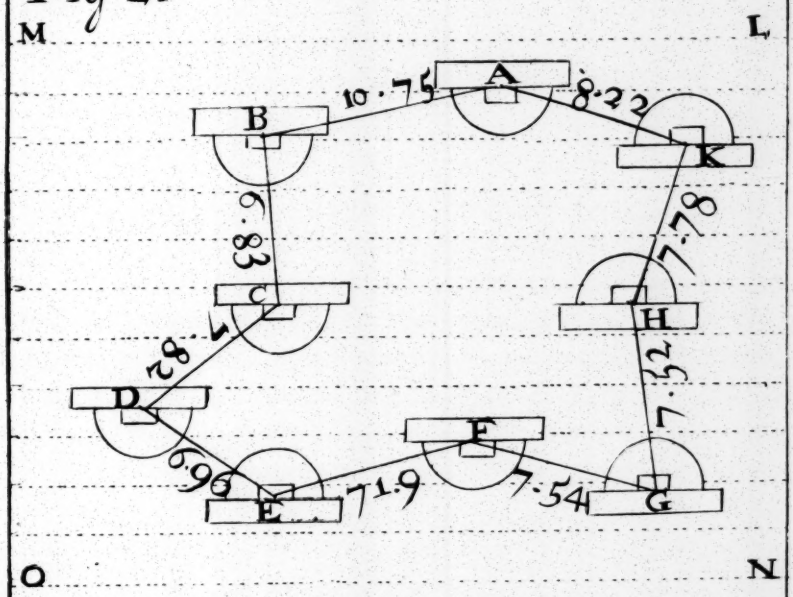


Fig 20

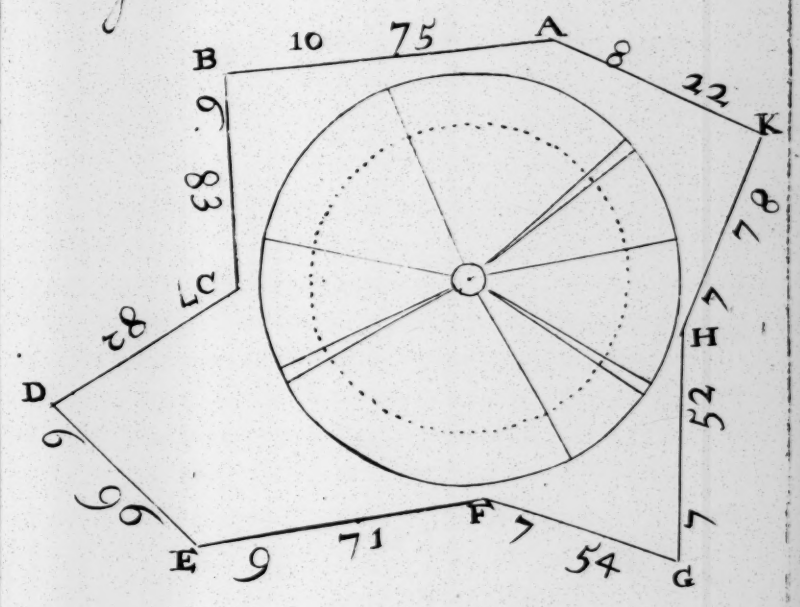
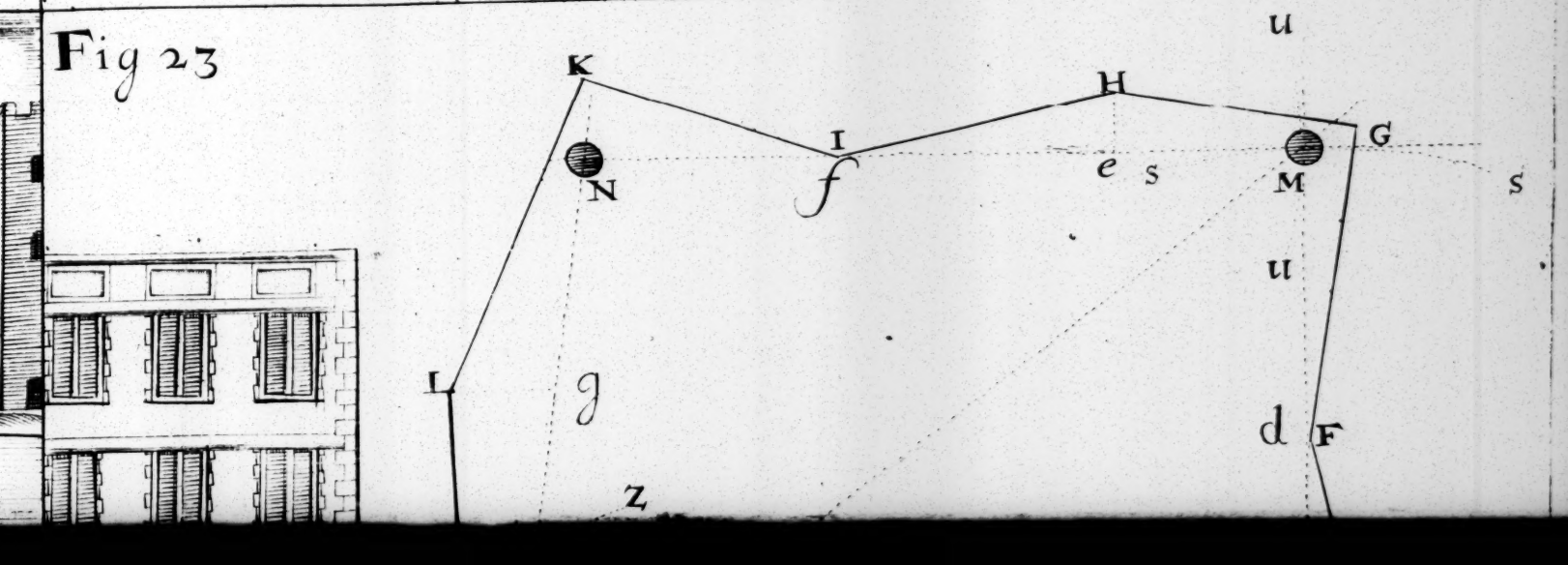
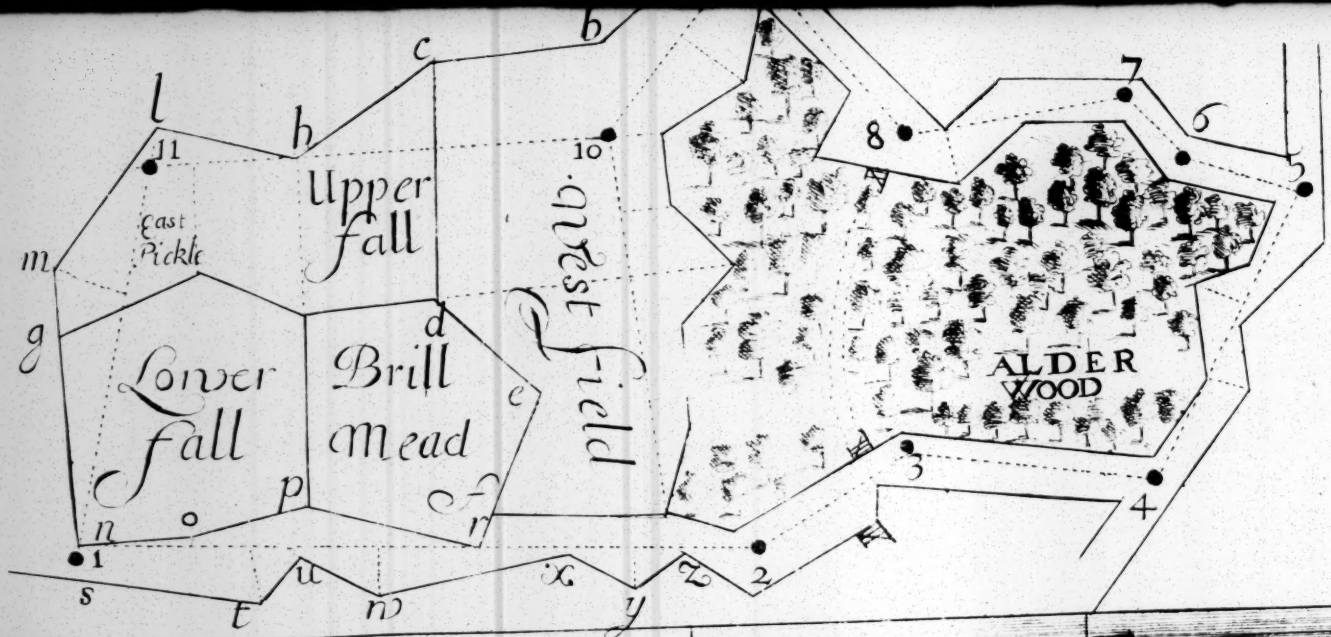
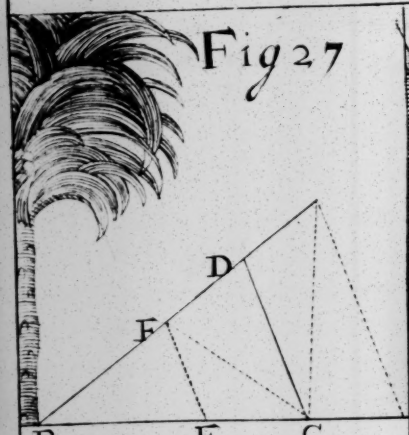
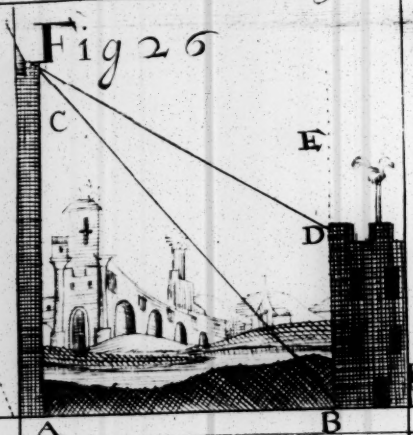


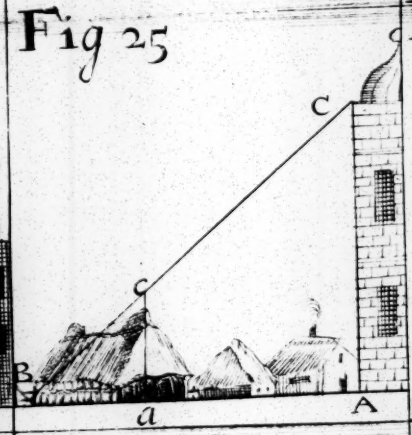
Fig 23

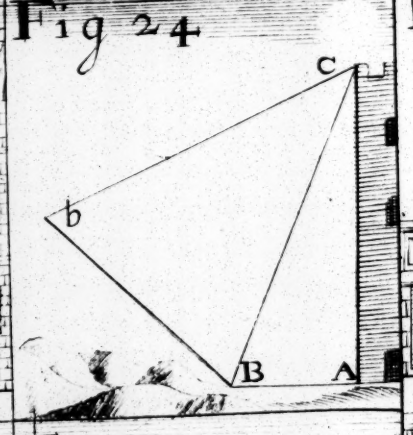


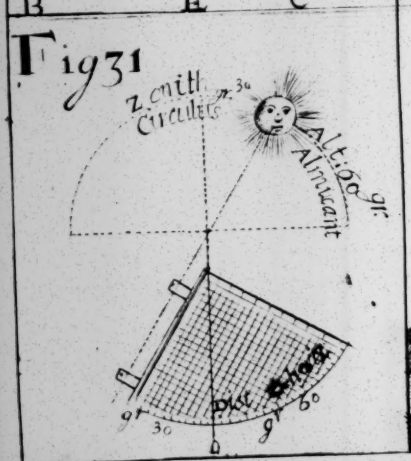


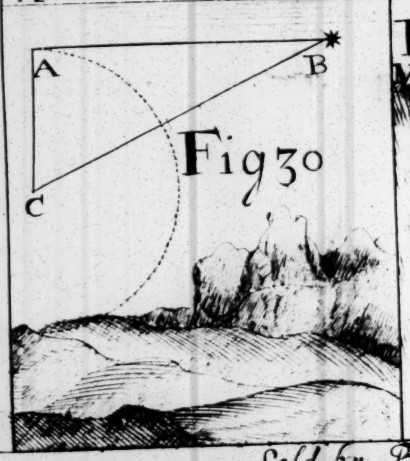


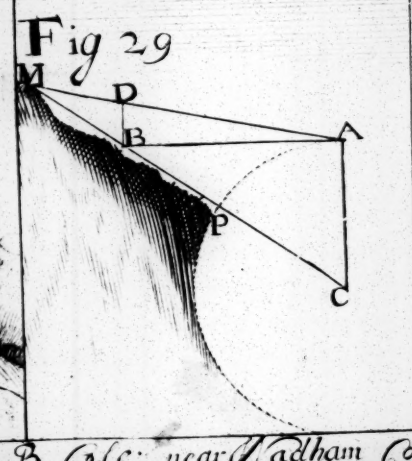


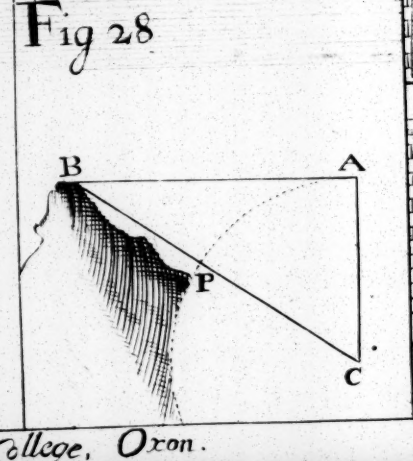




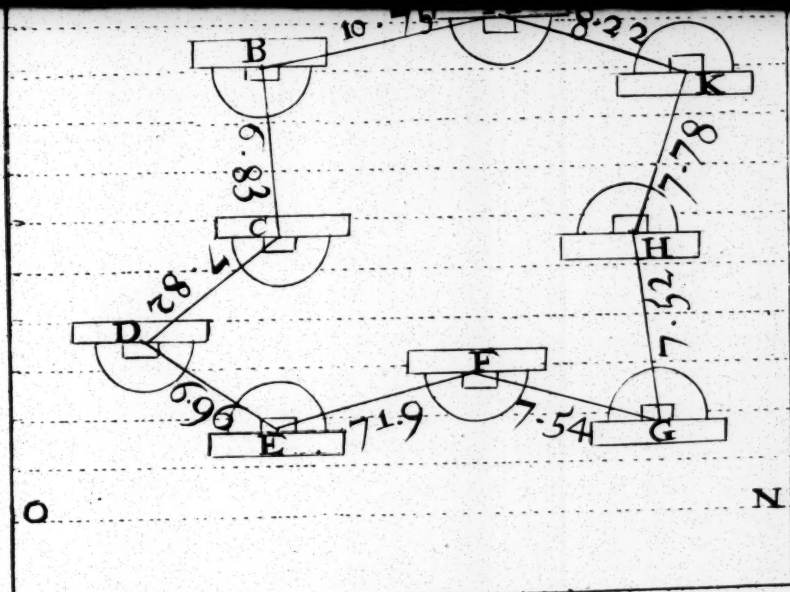








Sold by B. Cole near Cadham College, Oxon.



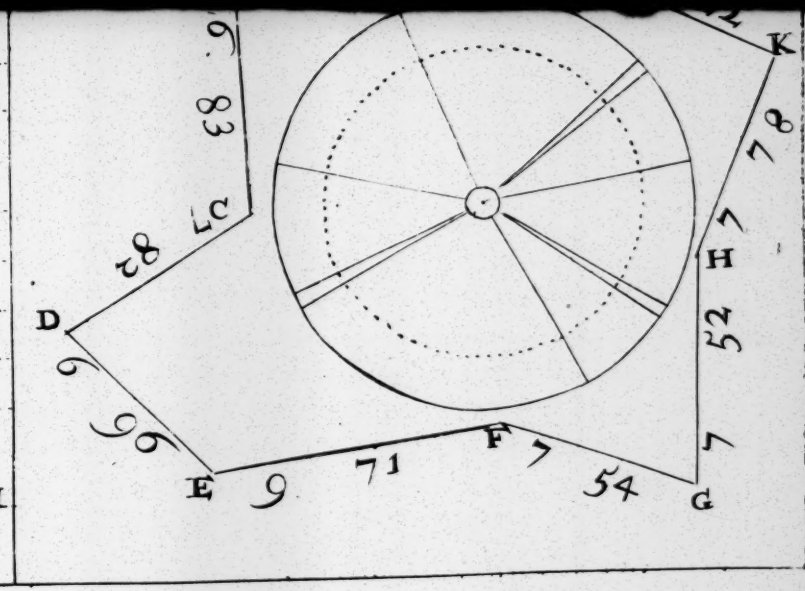
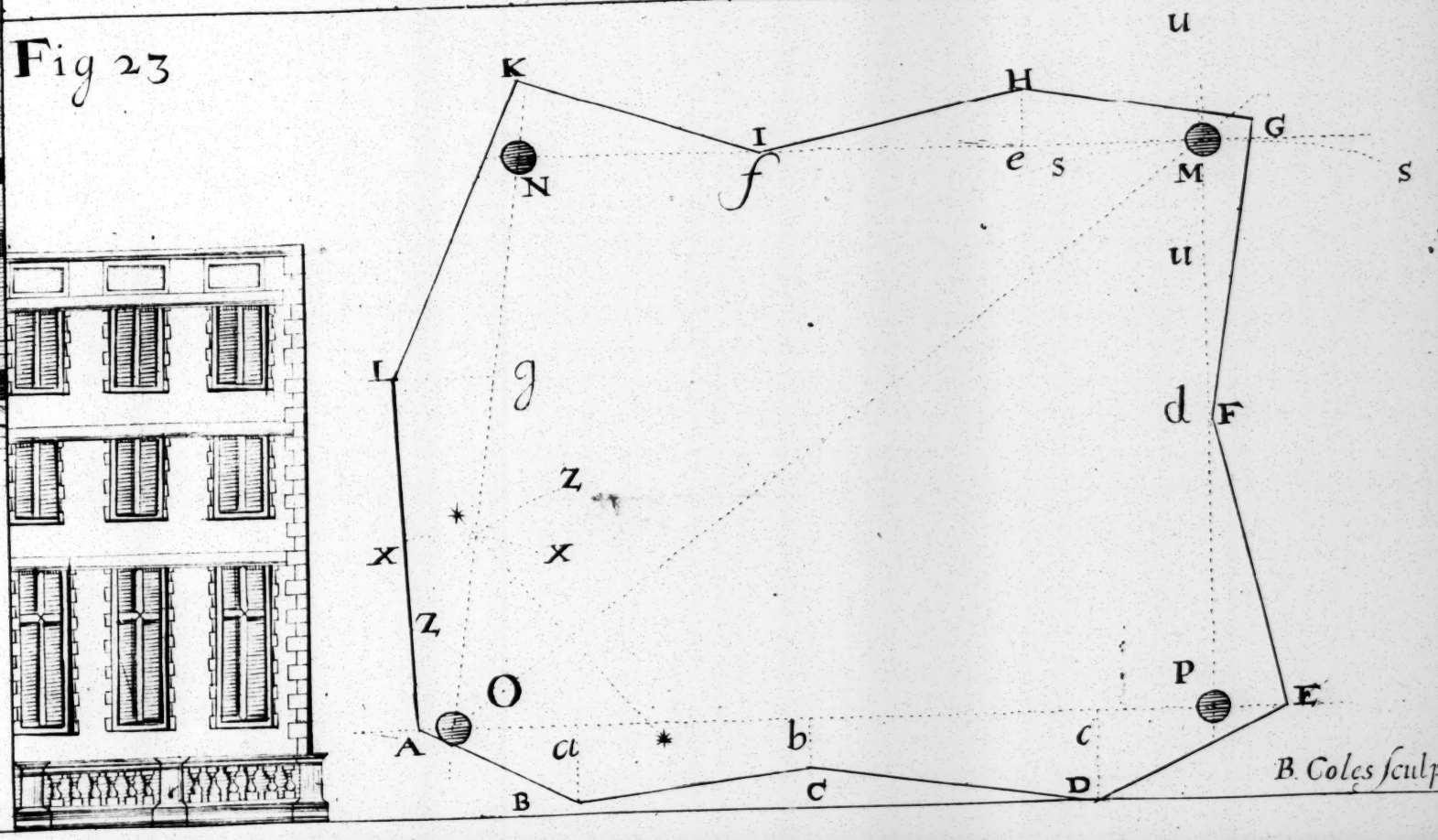


Fig 23



B. Coles sculp